whole *Principia mathematica* was finally published.[101] In a famous Scholium to the Definitions of Book One, Newton expounded his conception of absolute space, time, and motion and contrasted them with their relative counterparts. At the time, he did not make any explicit metaphysical or theological claims about the nature of space—these would arrive later, in the *Quaestiones* of the 1706 Latin *Optice*, and in the *Scholium generale* of the 1713 edition of the *Principia*. In 1687, however, Newton offered some important remarks on what he believed space, place, and situation to be.

In the Scholium, in particular, he gave a definition of place (*locus*) as the part of space that a body occupies.[102] A place is therefore a three-dimensional extension. Newton famously distinguished between relative (mobile) and absolute (immobile) space, but also between relative and absolute place (*locus absolutus*). He introduced the notion of *situs* as an 'attribute of place' (*affectio loci*) and claimed that relative spaces have a *situs* with respect to certain bodies taken as reference points. He went on to say that absolute and relative spaces are *essentially places*, that is, they may be occupied by other things (and, he added, by themselves). More than this, all things are in space (this is a strong metaphysical claim, coming from the *De gravitatione*), and things are placed in space according to an *order of situation*:

> For times and spaces are, as it were, the places of themselves and of all things. All things are placed in time with reference to order of succession and in space with reference to order of situation (*ordo situs*). It is of the essence of spaces to be places, and for primary places to move is absurd. They are therefore absolute places (*absoluta loca*), and it is only changes of position from these places that are absolute motions.[103]

[101] For the circumstances of the composition and publication of the *Principia*, see R. S. Westfall, *Never at Rest. A Biography of Isaac Newton* (Cambridge: Cambridge University Press, 1980).

[102] This characterization of place as something occupied by bodies is classical and can be found in many Greek sources. It recurs also in Newton's *The Lawes of Motion* (in Hall and Hall, *Newton*, 157).

[103] I. Newton, *Philosophiae naturalis principia mathematica* [*Principia*] (London: Streater, 1687), 5–6, trans. in I. Bernard-Cohen and A. Withman (eds.), *Newton. The Principia* (Berkeley: University of California Press, 1999), 410, modified; the editors are inconsistent in translating '*situs*' as 'situation' or 'position'. The statement that everything which exists is in space is, of course, of great metaphysical consequence, even though Newton did not stress its entire significance in the Scholium. See some famous passages to this effect in the *De gravitatione* (Hall and Hall, *Newton*, 103). The theme is taken over in the Leibniz-Clarke correspondence, in which Clarke claimed that 'Space is the Place of All Things and All Ideas' (Fourth Reply, §29; Robinet, *Leibniz–Clarke*, 113), much to Leibniz's dismay (Fifth Letter, §§79–81; Robinet, *Leibniz–Clarke*, 162).

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The concept of *situs* was not mentioned again in the course of the book and played no role in Newton's demonstrations.

In the same months in which Newton published these lines, Leibniz had left his work in the Harz mines and was preparing for a trip to Southern Germany to trace the history of the House of Hanover. His correspondence with Arnauld on substances and phenomena was in full bloom. Leibniz left Hanover in October 1687 and soon realized that his historical research needed to take him to archives in Italy; while in Munich, he asked to be admitted to Modena's libraries, but permission was delayed for a long time. Leibniz decided to wait in Vienna, where he spent nine months, from May 1688 to February 1689. Here, Leibniz was busy with many political, economic, and cultural plans that he had a chance to present to the Emperor himself at a hearing in October 1688.[104]

As soon as he arrived in Vienna, Leibniz also read Christoph Pfautz's review of Newton's *Principia* in the June 1688 issue of the *Acta eruditorum*.[105] By the end of the year, he had already written the first of his own replies to Newton's theory of universal gravitation, in which he offered an alternative theory that did not make use of either attraction at a distance or absolute space. During the intervening months, Leibniz had read and annotated the *Principia* itself and penned a series of remarks on it. These notes do not say much about space and limit themselves to registering Newton's opinions on the subject.[106] Nonetheless, in the same months Leibniz was also busy with other philosophical endeavors. The correspondence with Arnauld had come to an end during Leibniz's stay in Southern Germany, and Leibniz seems to have felt the need to update and render precise the great synthesis of the *Discours de métaphysique*. He wrote a new essay, covering some of the same

[104] On the details of Leibniz's life in these years, see M. R. Antognazza, *Leibniz. An Intellectual Biography* (Cambridge: Cambridge University Press, 2009).

[105] The review appeared anonymously and did not comment much on the Scholium on space, time, and motion. It included, however, Newton's remarks that his conception of space was non-Aristotelian and that it did not go against Scripture: C. Pfautz, 'Isaaci Newton, Matheseos Professoris Cantabrigiensis . . .', *Acta Eruditorum*, 1688, 303–15, at 305. On this review, see I. Bernard Cohen, 'The Review of the First Edition of Newton's *Principia* in the *Acta Eruditorum*, with Notes on the Other Reviews', in P.M. Harman and A.E. Shapiro (eds.), *The Investigation of Difficult Things* (Cambridge: Cambridge University Press, 1993), 323–54.

[106] For the detailed chronology of Leibniz's reading of Newton's *Principia* and the drafting of his anti-Newtonian works, see D. Bertoloni Meli, *Equivalence and Priority: Newton versus Leibniz* [*Equivalence*] (Oxford: Clarendon Press, 1993), which also contains an edition of Leibniz's early notes on the *Principia*, written in Vienna. Leibniz continued to take notes on Newton's book during his trip to Italy, and Bertoloni Meli also published this second set of notes (which are mostly *excerpta*) in D. Bertoloni Meli, 'Leibniz's Excerpts from the *Principia Mathematica*', *Annals of Science*, 45 (1988), 477–505. Leibniz's (undated) marginal notes to the *Principia*, which constitute a third set of annotations, are published in E. A. Fellmann, *Marginalia in Newtoni Principia Mathematica 1687* (Paris: Vrin, 1973).

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topics as the *Discours*, which he called the *Specimen inventorum*. This text is written on Vienna paper, and therefore overlaps with, or comes shortly after, Leibniz's reading of the *Principia*.

The *Specimen* has a marginal note, in which space is defined as a relation for the first time ever:

> Space and time are not things, but real relations (*relationes reales*). There is no absolute place (*locus absolutus*) or motion, since there are no principles for determining the subject of motion.[107]

This short remark, quite disconnected from the rest of the essay and appended there as witness to the spark of an idea that had crossed Leibniz's mind, signals the birth of the relational theory of space. For Leibniz, there would be no going back.

Later in the same *Specimen*, Leibniz added that Descartes had correctly recognized that, *just like place* (*uti locus*), motions are entirely relational (*in solo respectu consistunt*). Later still, Leibniz repeated that there is no vacuum, and therefore no real space (*spatium reale*).[108]

These remarks, which crept into an essay that had probably not been conceived to accommodate them, seem to come straightforwardly from Leibniz's contemporary reading of the *Principia*. The connection with Newton's Scholium is apparent from Leibniz's reference to absolute place (*locus absolutus*), which is a recurrent term there and an expression that Leibniz himself used to abridge the content of the Scholium in his own notes on the *Principia*—it does not occur elsewhere in Leibniz's works.[109] The fresh discovery is also attested by Leibniz's phrasing: in later years, he would define space as an order of relations rather than 'a relation', as it is said to be here.[110]

[107] A VI, 4, N. 312, 1621; trans. in Arthur, *Labyrinth*, 313. This sentence is marked in the Academy edition as the second part of a longer marginal note on the nature of time, but the manuscript shows that it is in fact an isolated statement.

[108] A VI, 4, N. 312, 1622–3.

[109] See Bertoloni Meli, *Equivalence*, 223. Leibniz's only remark on the topic mentions absolute place and 'immobile' (rather than 'absolute') space: 'Motum absolutum aestimat a loco absoluto, scilicet respectu spatii immoti'. In the seventeenth century, the expression 'absolute place' was not common at all, and Newton may have introduced it: see R. DiSalle, 'Absolute Space and Newton's Theory of Relativity', *Studies in History and Philosophy of Modern Physics*, 71 (2020), 232–44. In some texts on *analysis situs*, Leibniz called *spatium absolutum* the whole space (as opposed to a part of it), but this was not Newton's sense of the expression (see above, note 82). In some texts written shortly after the *Specimen inventorum* (see below), Leibniz used the term 'absolute space' in Newton's sense.

[110] Indeed, Leibniz corrected Clarke when he said that for Leibniz space was 'a situation' (Fourth Reply, §41; Robinet, *Leibniz–Clarke*, 115). Leibniz replied: 'Je ne dis point donc que l'espace est un ordre ou situation, mais un ordre des situations . . .' (Fifth Letter, §104, in Robinet, *Leibniz–Clarke*, 171).

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